Monitoring Restoration of Off-channel Habitats for Pacific Salmon

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Abstract
Off-channel habitats (such as sloughs, beaver ponds, wetlands and other permanently or seasonally flooded lands) are important rearing areas for juvenile salmonids. As floodplains have been routinely isolated or impacted by adjacent land use practices, off-channel habitats have been lost. The objectives of this project are to determine the effectiveness of various off-channel habitat restoration techniques by (1) gathering and summarizing known information on off-channel salmonid production, and (2) determining what physical, biological, and hydrological features characterize the most successful projects. Based on analysis of smolt-trapping data from more than 30 off-channel sites in Washington State, we found that constructed groundwater channels were particularly productive for juvenile coho salmon *(Oncorhynchus kisutch)*. We evaluated fish use at a set of constructed and reference groundwater channels in two geographic provinces: the North Sound and Olympic Peninsula of Washington State. Although we observed five salmonids species using these off-channel habitats, coho overwhelmingly comprised the dominant species, particularly at constructed channels. We also collected temperature, nutrient, and invertebrate data so as to evaluate the specific relationships between these site characteristics and fish use parameters. Knowledge of these relationships will help to establish future guidelines for the design and construction of off-channel habitats.

Extended Abstract

Introduction
Off-channel habitats (such as sloughs, beaver ponds, wetlands and other permanently or seasonally flooded lands) are important rearing areas for juvenile salmonids, particularly coho salmon (*Oncorhynchus kisutch;* Bustard and Narver 1975; Peterson 1982a; Swales and Levings 1989). Off-channel habitats frequently contribute a very high proportion of total coho salmon smolt production for a given river basin (Nickelson et al. 1992). Not only are coho densities often very high in off-channel habitats, but overwinter survival and growth may be substantially enhanced, particularly where cover and an invertebrate food supply are abundant (Peterson 1982b; Swales and Levings 1989). Recent studies suggest that overwintering habitat is a significant factor limiting coho production in many coastal Northwest basins (Beechie et al. 1994; Solazzi et al. 2000).

As floodplains have been routinely isolated or affected by adjacent land-use practices, off-channel habitats have been lost. Given both the ecological importance of off-channel areas and their diminishing occurrence, many habitat enhancement efforts seek to re-create off-channel habitats through a variety of techniques (Lister and Finnigan 1997). These include: reconnection of isolated habitats such as oxbow lakes; large-scale excavation of riverine ponds or side channels; creation of dammed ponds; and gravel pit and mill pond reclamation. As with many types of restoration, formal publications documenting the effectiveness of various off-channel habitat restoration techniques are limited.

Study Objectives
The objective of this study is to help determine the effectiveness of off-channel habitat restoration by (1) gathering and summarizing existing information on fish use of off-channel habitats; (2) supplementing these existing datasets with habitat mapping at a sub-set of sites; and (3) comparing constructed off-channel habitats to their naturally-occurring equivalents. Analyses derived from habitat mapping in step two of the study are still in progress and are not discussed further. Based on analysis of existing smolt-trapping data in step one of this study, we found that constructed groundwater channels were particularly productive for juvenile coho salmon. We therefore focused in step 3 of this study on comparing constructed and naturally-occurring side channels, and limit the remainder of our discussion on this step of the study.

Methods

To investigate to what extent constructed channels functioned similarly to those occurring naturally in the floodplain, we selected paired reference channels similar in size and form and in proximity to constructed sites. At each site, we evaluated differences in physical habitat complexity, temperature regime, nutrient availability, and fish and invertebrate use. Sampling occurred in the late winter prior to the out-migration of salmonid smolts, and in the late summer prior to early fall freshets. Our geographic focus was coastal Washington State: we evaluated six paired sites on the Skagit River, and five pairs on the Hoh and Quileute Rivers.

Results

Analyses for this study are still in progress; presented below are preliminary results from winter habitat and fish sampling at Skagit River sites. On the five physical habitat measures tested, only percentage slow-water habitat was significantly different between constructed and reference channels. This variable, defined as the percentage of channel area comprised of pools and glides, was significantly higher in constructed channels (paired t-test, $n = 6$, $p < 0.05$). Of the fish use parameters, winter coho densities were significantly higher in constructed than reference channels (paired t-test, $n = 6$, $p < 0.05$). Although we observed five salmonids species using both types of channels, coho overwhelmingly comprised the dominant species, particularly at constructed sites.

Preliminary Conclusions and Next Steps

Based on preliminary results, constructed habitats support high densities of juvenile coho in the winter. These constructed habitats also appear to be more homogeneous than reference channels in terms of habitat diversity and the relative abundance of different fish species present. We are testing these results during summer months, and in a different geographic region. Our next step will be to tie together our multiple datasets so as to better understand how chemical, physical, and biological characteristics influence fish use of off-channel habitats. Knowledge of these relationships will help to establish future guidelines for the design and construction of off-channel habitats.

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